Introduction to Fluid Mechanics 1 st Midterm Exam **(sample exam)**

Time for the exam: 10:15 to 12:00.

Name:

NOTE: In multiple-choice questions, choose ONLY one answer.

Questions

Q1. () What are the units corresponding to the following variables (in SI)?

ρ (density):	μ (dynamic viscosity):
P (Pressure):	τ (shear stress):
Ev (Bulk modulus of Elasticity):	S (specific gravity):

Q2. () In the lower part of the stratosphere, the temperature:

a) Increases exponentially with height
b) Increases logarithmically with height
c) Increases linearly with height
d) Is constant with height
e) Decreases linearly with height
f) Decreases logarithmically with height
g) Decreases exponentially with height
h) None of the above

And the pressure:

a) Increases with height
b) Is constant
c) Decreases with height
d) None of the above

Q3. () When streamlines are curved, pressure will ---------- outward from the center of the curvature.

a) Increase
b) Decrease
c) Either increase or decrease

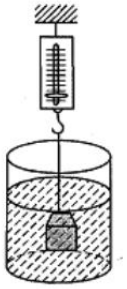
Q4. () Pathlines, streaklines and streamlines are coincident in ---------- flows.

a) Potential
b) Steady
c) Unsteady
d) None of them

Q5. () What can one measure with a water column barometer? (Really short answer, please) Do we need to calibrate such an instrument? (Yes/No)

Q6. () What height would a water barometer need to be to measure atmospheric pressure? (ρ_{water}=1000 kg/m^3, and $p_{atmosphere}$=100 kPa)

Q7. () The figure shows an object of mass 0.4 kg and volume 2.0 x 10^{-4} m^3 that is suspended from a scale and submerged in a liquid. If the reading on the scale is 3 N, then what the buoyant force that the fluid exerts on the object is? What is the density of the liquid?

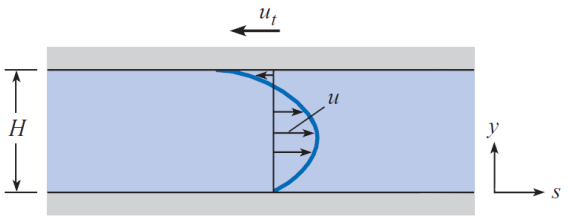


Q8. () The pressure in domestic water pipes is typically 500 KPa above atmosphere. If viscous effects are neglected, determine the height reached by the jet of water through a small hole in the top of the pipe. (Density of water=1000 Kg/m^3, g=10 m/s^2)

Problems

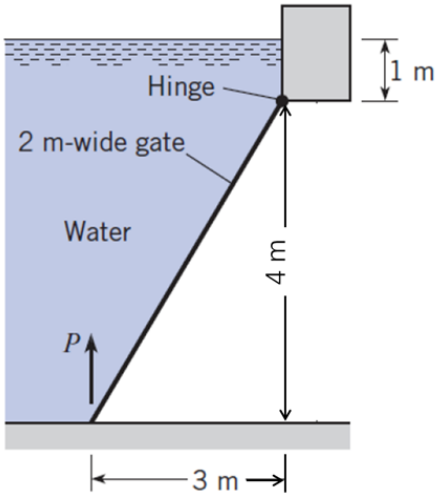
P1. () A laminar flow occurs between two horizontal parallel plates under a pressure gradient *dp/ds* (*p* decreases in the positive s direction). The upper plate moves left (negative) at velocity u_t. The expression for local velocity u is given as:

$$u = -\frac{1}{2\mu}\frac{dp}{ds}(Hy - y^2) + u_t\frac{y}{H}$$

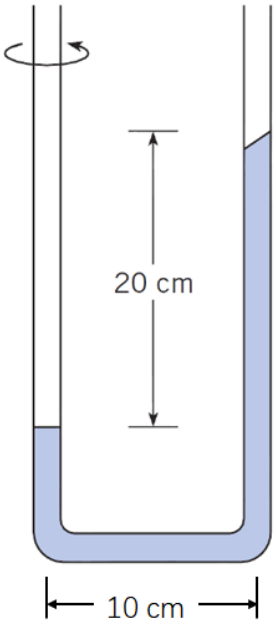


a. Is the magnitude of the shear stress greater at the moving plate (y=H) or at the stationary plate (y=0)?
b. Derive an expression for the y position of zero shear stress.
c. Derive an expression for the plate speed u_t required to make the shear stress zero at y=0.

P2. () Determine P necessary to just start opening the 2 m–wide gate.

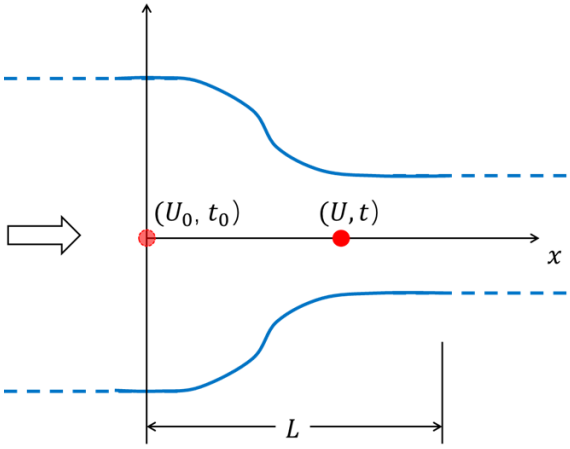


P3. () A manometer is rotated around one leg, as shown. The difference in elevation between the liquid surfaces in the legs is 20 cm. The radius of the rotating arm is 10 cm. The liquid in the manometer is oil with a specific gravity of 0.8. Find the number of g's acceleration in the leg with greatest amount of oil.



P4. () In a contraction pipe, the centerline velocity is varying with time, t and distance inside the contraction, x, as follows:

$$U(x,t)=\frac{U_0 t/t_0}{\left(1-0.5x/L\right)^2};\qquad L=2m,\ \ U_0=2m/s,\ \ \mathrm{t}_0=1s$$



(a) What is the local acceleration at the contraction?

(b) What is the convective acceleration at the contraction?